DOCUMENT RESUME

ED 476 706 SE 067 881

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TITLE	Quality and Quantity in the Mathematics Curriculum.
PUB DATE	2003-05-18
NOTE	9p.
PUB TYPE	Opinion Papers (120)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	Curriculum Development; *Educational Objectives; Educational Principles; Educational Quality; Elementary Secondary Education; Evaluation; *Mathematics Education

ABSTRACT

This paper presents cognitive, affective, and psychomotor objectives and appraisal procedures in mathematics. It emphasizes the development of achievable mathematics curriculum and ongoing and sequential assessment to provide appropriate order of mathematical experiences for students. (KHR)

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[Quality and Quantity in the Mathematics Curriculum]

[Marlow Ediger]

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QUALITY AND QUANTITY IN THE MATHEMATICS CURRICULUM

Mathematics, a basic in the curriculum, is heavily emphasized, along with reading, in state mandated testing. To have a good mathematics curriculum, carefully chosen objectives need to be in the offing and implemented in the instructional arena. These objectives need to stress a balance among cognitive, affective, and psychomotor ends. Teaching and learning contain a plethora of specifics which are necessary to adhere to. Thus to do the best possible, the pupil needs adequate nutrition, sleep, and decent living facilities. Then too, the pupil must feel safe in school and in the home setting as well as experience en route safety between home and school. A school needs to be a place where pupils feel they belong and are accepted by others. Feelings of rejection are highly negative. The entire school system needs to work in the direction of pupils and school personnel being highly accepting of others in a multicultural environment. Also, a pupil desires to be known for something done well. The school and classroom setting need to provide opportunities for pupils individually to be successful learners and thus receive praise for achievement and progress. Self confidence in mathematics is a must in the curriculum (See Maslow, 1954).

Cognitive Objectives in Mathematics

Each cognitive objective needs to be chosen carefully in mathematics. Quality sequence of objectives begins in the preschool years and goes throughout higher education. Thinking skills are vital in mathematics. Too many teachers stress rote learning and memorization of mathematics content. This is not adequate. Pupils need to understand what is being learned. To understand means to attach meaning to ongoing lessons and units of study. Any number pair, for example, such as 8+7 may have a memorized answer but this is survey, not depth learning. Learners need to attach meaning to "8" representing a quantity of objects which can be counted as a set. This is true no matter how large the addends are. The foundation for meaningful mathematics learnings must begin early in the child's life.

Logical thing needs adequate emphasis in mathematics. The commutative, associative, and distributive properties then should sequentially be stressed. A child may learn the logic in that 8+7 = 15, a swell as 7+8= 15. At any age level, this

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commutative property of addition saves much time in learning in that it cuts in half the number of addition facts to be learned. Logical thinking transfers in sequence to all branches of mathematics.

Critical thinking is salient in that pupils need to be able to analyze mathematical subject matter. For example, any value then such as 5123 might be analyzed in terms of thousands, hundreds, tens, and ones. Column addition stresses that the ones need to be added to ones, tens to tens, hundreds to hundreds, and thousands to thousands with the possibilities of regrouping and renaming. Later on, increasingly complex numerical values and reasoning will be involved.

Inherent in critical thinking is creative thought. Here, the pupil needs to be flexible in terms of using a variety of algorithms. There are diverse algorithms which might be used in coming up with answers in problem solving. Then too, problem solving requires identifying a problematic situation, gathering information, developing an hypothesis, and testing the hypothesis in a life like situation. Deliberations is involved. It takes time and effort to solve relevant problems. Within the framework of critical and creative thinking, problem solving is vital as well as useful. Subject matter is used creatively as needed to solve problems.

Being able to estimate well and check the estimation correctly is a vital skill. Estimating in mathematics is a highly useful and important skill in every day life. Mentally in being able to estimate well in specific situations is emphasized in terms of time, distance, volume, and area. A practical use of estimation must be stressed in the curriculum.

Being able to interpret graphic information correctly is necessary when gleaning information from the media. Thus line, bar, picture, and circle graphs, need interpretation as to what is being conveyed. Knowledge of correct interval size and statistical procedures such as in using the mean, median, mode, quartile as well as standard deviation, among others, need to be taught developmentally. Meanings need to be attached to grouped and ungraded numerical data as well as descriptive and inferential statistics. Inferences need to be made of carefully collected and organized statistical data.

A rich mathematics vocabulary needs to be in the offing and integrated into each mathematical lesson and unit of study. Subject matter needs to be taught developmentally and sequentially in order provide learners with background information to master each new objective. No pupil should be left behind without a well defined scope and sequence program

of mathematics (Ediger and Row, 2000, Chapter One).

Affective Objectives in Mathematics

Too frequently, affective objectives are minimized in teaching due to the inability to accurately measure if these kinds of objectives have been achieved by pupils. The teacher, through daily observation, may notice the quality of attitudes possessed by pupils. Growth in a desire to achieve more optimally in mathematics, as an attitude, provides opportunities for pupils to attain vital facts, concepts, and generalizations in mathematics. These learnings need to be reflected upon and communicated to others in an atmosphere of respect. Accepting others makes committee endeavors more enriching and pleasant. Rudeness and a lack of tolerance toward others has no place in situations where pupils interact with each other.

Neat, legible, and accurate writing is necessary when communicating mathematical ideas in writing. Communication skills are important in mathematics, including the ability and desire to convey ideas orally. Processes and procedures in mathematics need to be conveyed which are meaningful to other pupils, the teacher, and parents in the home setting. Wanting to communicate clearly and accurately provides opportunities to develop thinking abilities. Each learning obtained provides a foundation for achieving increasingly more complex ideas. It takes understanding and quality attitudes to attach meaning to vital subject matter such as fundamental operations on number, linear measurement, area, volume, weight, ratio and proportion, among others salient learnings. The pupil needs to have an inward desire to learn and achieve. Quality attitudes then in the affective dimension aid pupils to achieve and accomplish. Having good attitudes go a long way in doing well in a developmental mathematics curriculum (See New, 2003).

Psychomotor Objectives in Mathematics

Ample and meticulous attention must be given to psychomotor objectives in the mathematics curriculum. These kinds of objectives emphasize pupils applying what has been learned. When application is made, pupils practice what has been learned previously. Retention of learnings is improved upon when facts, concepts, and generalizations are used by pupils. Using that which has been learned also makes it possible for review and practice to take place in a meaningful way.

However, in applying learnings, meaningless drills are minimized. Making application may mean using what has been learned in a new process, skill, or practical situation. There are a plethora of situations in which previously achieved ideas in mathematics may be used. The following are several suggested learning opportunities:

1. making mathematical models.
2. constructing items where mathematics is used in an ongoing unit of study.
3. dramatizing a mathematical situation.
4. drawing diverse geometrical figures to show design and spatial relations.
5. modeling a process or procedure to share with others.

Then too in every day life, pupils need to use what has been learned in mathematics applied to practical situations. When items are purchased or sold, mathematics is needed in making these transactions (See National Council Teachers of Mathematics, 1989).

In all kinds of psychomotor, affective, and cognitive objectives being emphasized in teaching mathematics, the teacher needs to follow principles of learning from the psychology of education, including the following:

1. learning activities need to actively engage pupils. Pupils need to be wholeheartedly involved in ongoing lessons and units of study. The chances are a passive child will not learn much in mathematics.
2. pupils need to make sense of subject matter taught and learned. It wastes learner time if a lack of understanding results from the facts, concepts, and generalizations being taught.
3. motivation is a powerful factor in learning. With quality learning opportunities, pupils should feel energized to learn, to do, and to accomplish. Adequate motivation provides an inward desire for pupils to acquire mathematical learnings.
4. learning styles need to be stressed in teaching pupils. Thus, selected pupils like to learn in collective situations whereas others prefer individual endeavors.
5. the teacher needs to select interesting activities to achieve objectives. This is important in order to secure pupil attention in the lesson presentation.
6. individual differences need adequate provision since pupils differ from each other in talents and abilities. Each pupil needs to achieve as optimally as possible in the curriculum.
7. a variety of appraisal procedures need to be used to ascertain pupil achievement. Achievement in cognitive, affective,

and psychomotor objectives need to be evaluated in terms of quality criteria (See Peressini,1997).

Appraisal Procedures in Mathematics

There are diverse evaluative procedures available to measure mathematical achievement. State mandated testing is one procedure to ascertain what pupils have learned. One kind is norm referenced whereby each pupil may be compared on a grade level with others in the nation. Thus, a local pupil's score may pertain to being on the 34th percentile, for example. This means that out of every 100 pupils having taken the test, 66 pupils are higher and 34 are lower in making the comparison. There are no accompanying objectives for the teacher to use in teaching when norm referenced tests are used. From pupil test results on the norm referenced test, there will be a spread of scores from the 99th down to the first percentile. Criterion referenced tests (CRTs), developed state wide, do have accompanying objectives for the teacher to use in teaching. The subject matter taught then is valid in terms of what will be covered, in general, on the test. The spread of scores from high to low will be much less from CRT results as compared to norm referenced testing. Norm referenced test writers plan for a spread of test results from the 99th to the first percentile whereas CRTs emphasize, if possible, that all pupils be successful in learning. The objectives furnished to the teacher harmonize with the CRT so that is a better chance for pupils to score higher on the CRT as compared to the norm referenced test (Ediger, 1995, 7- 10)).

Second, teacher observation may be used continuously. Here, the teacher may notice the kinds of errors made by pupils and assist in remediation. The teacher may record the common kinds of errors made by pupils in class and then remedy these in small group or large group instruction. Errors made may be due to a lack of knowledge, carelessness, haste, incorrect copying of numerals to perform mathematical operations, a lack of legibility in writing numerals, and/or neatness, among others.

Third, teacher written tests may help ascertain what pupils have learned in mathematics. These might be multiple choice, true/false, matching, short answer, completion, and/or essay. Each kind of test has a different purpose for its use as compared to the others. For example, multiple choice test items may largely measure salient facts learned by children whereas essay tests may stress problem solving, emphasizing higher levels of cognition.

Fourth, a test may emphasize multiple languages to reveal information acquired in mathematics. Thus, a young child may show that 4+ 5 = 9 by using beads with a set of four yellow and five read beads, totaling nine beads whereas a different child may show the same addition fact with four white tally marks and five red tally marks on the chalkboard to indicate a sum of nine. The four basic operations on number may be shown in a plethora of ways including blocks, strips of paper, pencils, chalk, buttons, among others.

Fifth, daily discussions might well reveal what a pupil has learned in a lesson or unit of study. The pupil may indicate learnings acquired in a discussion by participating actively, showing a learning asked for with a drawing on paper or use of every body show cards whereby a child may answer a question by holding up the correct card such as "five" in answer to an addition, subtraction, multiplication, or division number pair, i.e. 9x8 = , shown on a card.

Sixth, teacher made materials can be excellent to use in teaching. For example, two pupils may use flash cards in drill and practice. One person then shows a card and the other provides the answer. The flash cards are stacked face down on a pile. The roles of pupils may reversed after the first pupil is through responding to the face down pile of cards.

Selected teachers have also made excellent game boards with a pupil moving forward one space if he/she answers correctly to a number pair on a card, originally turned face down. The first child who comes to the end of the race track, by moving forward one space at a time for each item answered correctly wins the game.

Seventh, workbook exercises completed by pupils in meaningful activities may provide the teacher with much information about a pupil's achievement in mathematics. Working pages in a workbook for the sake of doing so has little value. Rather, there must be a clear pupil purpose for working an exercise.

Eighth, software programs may well provide challenges to pupils in mathematics achievement. Tutorials provide new learnings to pupils. Each program is sequenced by the programmer and each answer given provides immediate feedback to the learner. Continuous evaluation based on each response provided by a learner gives the teacher necessary information on a pupil's progress. Drill and practice programs give the learner opportunities to practice skills in mathematics in which weaknesses have been exhibited previously. Pupils should experience drill and practice based on need and not for

the sake of doing so. Simulation programs emphasize life like situations in mathematics in which pupils solve realistic problems. Continuous feedback is provided pupils in problem solving. Gaming programs provide the learner chances to use a game like approach in achieving new concepts and generalizations in mathematics. The game may be played individually or within a small group or committee. The computer monitor shows what the pupil has learned and which learnings are presenting difficulties (Ediger, 1989, 20- 23).

In Closing

Pupils need to have challenge, yet an achievable mathematics curriculum. Each pupil needs to learn as much mathematics as possible for use in school and in society. The objectives of instruction need to be chosen carefully by involved persons. The learning opportunities to achieve objectives need to assist in providing for individual differences among learners. Assessment must be ongoing and sequential to provide appropriate order of mathematical experiences for pupils.

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